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The ITER baseline scenario investigated at ASDEX Upgrade

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At ASDEX Upgrade experiments have been performed, in which important features of the ITER baseline (ITER BL) scenario are matched or imitated. A crucial property of the ITER BL scenario is the combination of $q_{95} = 3$ with strong plasma shaping, which leads to ELM frequencies (f_{ELM}) as low as 10Hz, while the ELMs are very large.

One consequence of the low f_{ELM} is that access to ITER-relevant collisionalities has been hindered as a strong deuterium (D) gas puff is required to control the W-concentration. The large D gas puff is also suspected [1] to diminish the energy confinement leading to $H_{98(y,2)}$-factors in the range of 0.85 at the relevant $\beta_N = 1.8$, while the Greenwald fraction (f_{GW}) is at relevant levels (˜0.85). In order to achieve the desired performance, strategies for confinement improvement are investigated, such as increasing $q_{95} = 3$ while decreasing the D gas puff or applying N-seeding. However, these routes do not seem to be able to recover sufficient confinement.

While exploring strategies to go towards low ν^* in the ITER BL scenario, the use of MP-coils yielded a breakthrough allowing for an almost match of ITER collisionalities, i.e. $\nu^*/\nu^*_{ITER} \approx 3$, and for a clear decoupling of ion and electron heat fluxes. The low collisionalities were obtained by density pump-out of more than a factor of 2, while the confinement is almost not diminished. When extrapolating β_N of such a phase heated with NBI and ICRH to ITER relevant values, sufficient confinement is expected. At the same time ELMs are either very small or even suppressed in some cases.

However, when MP-coils are applied to the high density ITER BL scenario matching f_{GW} instead of ν^*, only a small pump-out effect (˜10%) and almost no effect on the ELM size is observed. The density dependence of the MP-coil effectiveness is consistent with [2]. In order to mitigate ELMs at high density, pellet pace making, strong gas puffing or a slight shape or position change proved to be more efficient than the application of MP coils. It is remarkable that corresponding high density discharges in helium behave very similarly, w.r.t. the negligible MP coil effect and the accomplishment of small ELMs at large neutral helium density.

[1] J. Schweinzer et al, NF 56, 2016;
[2] N. Leutholt et al, PPCF 59, 2017

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